ANSWERS: Enthalpy change calculations

1) available in April 2015

2) $n(C_4H_{10})$ = 100 g / 58.1 g mol^{-1} = 1.7212 mol
–4960 kJ / 1.7212 mol = –2882 kJ mol^{-1}

3) n(Fe) = 2000 g / 55.9 g mol^{-1} = 35.78 mol
Fe_3O_4:
3348 kJ / 9 = 372 kJ mol^{-1}
372 kJ mol^{-1} × 35.78 mol
= 13 310.16 kJ
= (–)1.33 × 10^4 kJ
Fe_2O_3:
851 kJ / 2 = 425.5 kJ mol^{-1}
425.5 kJ mol^{-1} × 35.78 mol = 15 224.4 kJ
= (–)1.52 × 10^4 kJ

Therefore Fe_2O_3 produces more heat energy when 2 kg iron is formed.

4) 128 g / 16.0 g mol^{-1} = 8.00 mol
8.00 mol × 889 kJ mol^{-1} = 7112 kJ

5) $n(O_2)$ = 15.4/32 = 0.481 mol
Energy released = 0.481 × 1200 = 578 kJ
M(Mg) = 24.0 g mol^{-1}
1200 kJ released by 2 mol Mg
98.2 kJ released by 98.2 × 2/1200 mol Mg
= 0.164 mol

6)

$$E = \frac{1652\ \text{kJ}}{2.00\ \text{mol}} = 826\ \text{kJ mol}^{-1}\ \text{(kJ)}$$

$$\text{Energy from 1 mol Fe} = \frac{1652\ \text{kJ}}{4\ \text{mol}} = 413\ \text{kJ mol}^{-1}$$

$$n(\text{Fe}) = \frac{4\ \text{mol} \times 185\ \text{kJ}}{1652\ \text{kJ}} = \frac{185\ \text{kJ}}{413\ \text{kJ mol}^{-1}} = 0.448\ \text{mol}$$

m(Fe) = nM= 0.448 mol × 55.9 g mol^{-1} = **25.0 g**

7)

$m(H_2) = nM = 2\text{mol} \times 2\ \text{g mol}^{-1} = 4\ \text{g}$

$$\text{Energy per mol } (H_2) = \frac{570\ \text{kJ}}{2\ \text{mol}} = 285\ \text{kJ mol}^{-1}$$

$$n(H_2)\text{ in 1 g} = \frac{m}{M} = \frac{1\ \text{g}}{2\ \text{g mol}^{-1}} = 0.5\ \text{mol}$$

$$\text{Energy per g } (H_2) = \frac{285\ \text{kJ mol}^{-1}}{2\ \text{g mol}^{-1}} = 0.5\ \text{mol} \times 285\ \text{kJ mol}^{-1}$$

$= 143\ \text{kJ g}^{-1}$

$m(CH_4) = nM = 1\text{mol} \times 16\ \text{g mol}^{-1} = 16\ \text{g}$

$$n(CH_4) = \frac{m}{M} = \frac{1\ \text{g}}{16\ \text{g mol}^{-1}} = 0.0625\ \text{mol}$$

$$\text{Energy per g } (CH_4) = \frac{890\ \text{kJ mol}^{-1}}{16\ \text{g mol}^{-1}} = 0.0625\ \text{mol} \times 890\ \text{kJ mol}^{-1}$$

$= 55.6\ \text{kJ (or kJ g}^{-1})$

H_2 provides the most energy per gram of fuel

8) $n(NH_3)$ in 12.2 g sample = 12.2 / 17.0 = 0.718 mol (3s.f.)
4 mol releases 4 × 275 / 0.718 = 1530 kJ (3s.f.)

9) n(CaO) = 287 / 82.0 = 3.50 m(CaO) = 3.50 × 56.0 = 196 g

10) $n(C_2H_5OH) = \frac{18.4}{46.0} = 0.400$ mol

1 mol releases $\frac{546}{0.400} = 1365\ \text{kJ mol}^{-1}$

0.400

$\Delta H = -1365\ \text{kJ mol}^{-1}$

11)

$$\text{mol NaOH} = \frac{29.6\ \text{g}}{40.0\ \text{g mol}^{-1}} = 0.740\ \text{mol}$$

0.740 mol reacts to produce 43.5 kJ

$$\text{1 mol reacts to produce } \frac{43.5}{0.740} = 58.8\ \text{kJ}$$

$\Delta_r H = -58.8\ \text{kJ mol}^{-1}$

$$n(\text{NaOH}) = \frac{150\ \text{kJ}}{58.8\ \text{kJ mol}^{-1}} = 2.55\ \text{mol}$$

$m(\text{NaOH}) = 2.55\ \text{mol} \times 40.0\ \text{g mol}^{-1} = 102\ \text{g}$

12) *n*(jelly-baby) = 4.56 g / 342 g mol^{-1} = 0.0133 mol
E released = 0.0133 × 2192 kJ = 29.2 kJ
OR $\Delta_r H$ = -29.2 kJ
n($SrCl_2$) vaporised = 29.2 kJ / 343 kJ mol^{-1} = 0.0851 mol
m($SrCl_2$) = 0.0851 mol × 159 g mol^{-1}
= 13.5 g Allow follow-on if answer used from (i) is not 29.2 kJ.
Accept
0.0132 mol jelly-baby 28.8 kJ 0.0841 mol $SrCl_2$ 13.4 g $SrCl_2$

13)

$6.12 \times 5500 = 33\ 660$ kJ

$n(H_2) = 33\ 660/286 = 118$ mol (117.7)
$m(H_2) = 117.7 \times 2 = 235$ g